CLAIMS

The embodiments of an invention in which an exclusive property or right is claimed are defined as follows:

1. A method of producing a single mode VCSEL comprising the steps of:

forming a VCSEL structure having a substrate, a bottom contact portion disposed upon a lower surface of the substrate, a lower mirror portion disposed upon an upper surface of the substrate, an active region disposed upon the lower mirror portion, and an upper mirror portion formed from electrically isotropic material and disposed upon the active region;

providing a substantially equipotential layer disposed upon the upper mirror portion;

selectively interposing an electrically insulating layer between the upper mirror portion and the equipotential layer to form an aperture therebetween; and

providing an upper contact portion disposed upon the equipotential layer.

2. The method of claim 1 wherein the substrate is formed of Galium Arsenide material.

3. The method of claim 1 wherein the lower mirror portion is formed of a n-type material and the upper mirror portion is formed of a p-type material.

4. The method of claim 1 wherein the lower mirror portion is formed of a p-type material and the upper mirror portion is formed of a n-type material.

5. The method of claim 1 wherein the both the lower and upper mirror portions are formed of n-type material.

6. The method of claim 1 wherein the both the lower and upper mirror portions are formed of p-type material.

7. The method of claim 1 wherein the step of providing an equipotential layer further comprises providing a layer of material having a resistivity of 0.01 ohm/cm.

8. The method of claim 1 wherein the step of providing an equipotential layer further comprises providing a layer of Aluminum Galium Arsenide.

9. The method of claim 1 wherein the step of selectively interposing an electrically insulating layer further comprises interposing a plurality of distally separated insulating regions adapted to form the aperture.

10. The method of claim 1 wherein the insulating layer comprises an oxide.

11. The method of claim 10 wherein the insulating layer comprises Al_2O_3.

12. The method of claim 1 wherein the insulating layer comprises air.

13. The method of claim 1 wherein the step of providing an equipotential layer further comprises providing a layer of material having electrical conductance much greater than the conductance of the upper mirror portion.

14. The method of claim 13 wherein the step of providing an equipotential layer further comprises providing a layer of material having conductance at least four times greater than the conductance of the upper mirror portion.

15. The method of claim 13 wherein the step of providing an equipotential layer further comprises providing a layer of material having conductance at least ten times greater than the conductance of the upper mirror portion.

16. The method of claim 1 wherein the step of forming a VCSEL structure further comprises forming the upper mirror portion of material having low lateral conductance.

17. The method of claim 11 wherein the insulating layer is formed to reduce reflectivity outside the aperture.

18. The method of claim 11 wherein the insulating layer is formed to increase effective index outside the aperture and thereby produce a longer resonant wavelength outside the aperture.

19. The method of claim 11 wherein the insulating layer is formed to reduce reflectivity and to increase effective index outside the aperture.

20. The method of claim 1 wherein the step of forming a VCSEL structure further comprises forming an active region having a plurality of p-n junctions separated from each other by a tunnel junction.

21. The method of claim 1 wherein the step of forming a VCSEL structure further comprises forming a first heat conductive layer between the lower mirror portion and the active region, and a second heat conductive layer between the upper mirror portion and the active region.

22. The method of claim 21 wherein the forming of the heat conductive layers further comprises selectively doping the heat conductive layers in correspondence to electric field minima and maxima within the layer.

23. A single mode VCSEL comprising:

a VCSEL structure having a substrate, a bottom contact portion disposed upon a lower surface of the substrate, a lower mirror portion disposed upon an upper surface of the substrate, an active region disposed upon the lower mirror portion, and an upper mirror portion formed from electrically isotropic material and disposed upon the active region;

an equipotential layer disposed upon the upper mirror portion;

an insulating layer interposed between the upper mirror portion and the equipotential layer and adapted to form an aperture therebetween; and

an upper contact portion disposed upon the equipotential layer outside the perimeter of the aperture.

24. The VCSEL of claim 23 wherein the insulating layer comprises an oxide.

25. The VCSEL of claim 23 wherein the insulating layer comprises air.

26. The VCSEL of claim 23 wherein the equipotential layer comprises material having conductance at least four times greater than the conductance of the upper mirror portion.

27. The VCSEL of claim 23 wherein the equipotential layer comprises material having conductance at least ten times greater than the conductance of the upper mirror portion.

28. The VCSEL of claim 23 wherein the upper mirror portion comprises material having low lateral conductance.

29. A method of providing antiguide mode selectivity in a VCSEL comprising the steps of:

forming a VCSEL structure having a substrate, a bottom contact portion disposed upon a lower surface of the substrate, a lower mirror portion disposed upon an upper surface of the substrate, an active region disposed upon the lower mirror portion, and an upper mirror portion formed from isotropic material and disposed upon the active region;

providing a substantially equipotential layer disposed upon the upper mirror portion;

selectively interposing an electrically insulating layer between the upper mirror portion and the equipotential layer to form an aperture therebetween, wherein the electrically insulating layer is adapted to provide a greater nominal cavity resonance outside the aperture than inside it; and

providing an upper contact portion disposed upon the equipotential layer.

30. A VCSEL component, adapted to provided single mode operation over wide current ranges, comprising:

a semiconductor substrate having a lower surface and an upper surface;

a bottom electrical contact disposed along the lower surface of the semiconductor substrate;

a lower mirror formed of n-type material and disposed upon the upper surface of the semiconductor substrate;

an active region having a plurality of quantum wells disposed upon the lower mirror portion;

an upper current spreading mirror formed from electrically isotropic material and disposed upon the active region;

an equipotential layer disposed upon the upper mirror portion;

a first upper electrical contact disposed upon the equipotential layer at a first lateral end of the VCSEL component;

a second upper electrical contact disposed upon the equipotential layer at a second end of the VCSEL component at a particular distance from the first upper electrical contact; and

an insulating layer interposed between the upper mirror and the equipotential layer and adapted to form therebetween an aperture.

31. A method of producing a single mode VCSEL comprising the steps of:

forming a VCSEL structure having a substrate, a bottom contact portion disposed upon a lower surface of the substrate, a lower mirror portion disposed upon an upper surface of the substrate, an active region disposed upon the lower mirror portion, and an upper mirror portion formed from electrically isotropic material and disposed upon the active region;

providing a substantially equipotential layer disposed upon the upper mirror portion;

selectively interposing an electrically insulating layer between the upper mirror portion and the equipotential layer to form an aperture therebetween, wherein the insulating layer is formed to reduce reflectivity and to increase effective index outside the aperture; and

providing an upper contact portion disposed upon the equipotential layer.